Cyanobacteria spp.

Bacteroidetes spp.

Bacillariophyceae spp.

Giardia intestinalis
Bacteroidetes spp.

Domain: Bacteria
Size: 1 µm
Shape: Rod
Lives: Anaerobic soil, seawater, gut, and skin environments
Inputs/Outputs: Input sugars, amino acids and lipids, and use them to build cells. Output alcohols, hydrogen (H₂), and carbon dioxide (CO₂) as a result of fermentation.

Fun Facts:
• Bacteroidetes make up the largest portion of the mammalian gastrointestinal microbiota. In the host intestine, they play a fundamental role by breaking down complex molecules to simpler ones.
• Bacteroidetes are some of the most well studied bacteria.

Bacillariophyceae spp.

Domain: Eukaryota
Size: 5–30 µm
Shape: Variety
Lives: Anaerobic, aquatic and soil environments
Inputs/Outputs: Input sugars, amino acids and lipids, and use them to build cells. Output alcohols, hydrogen (H₂), and carbon dioxide (CO₂) as a result of fermentation.

Fun Facts:
• Bacillariophyceae are also known as diatoms
• Fossils suggest that diatoms evolved during or before the early Jurassic period.
• Measuring diatom communities is a popular method for monitoring environmental conditions and is commonly used to study water quality.

Giardia intestinalis

Domain: Eukaryota
Size: 15 µm
Shape: Flagellated protozoan (refer to image)
Lives: Anaerobic aquatic environments, guts
Inputs/Outputs: Uses sugars and produces ethanol and carbon dioxide (CO₂) through fermentation.

Fun Facts:
• If humans ingest or come into contact with contaminated food, water, or soil, these parasites cause the disease giardiasis. The disease is also called ‘beaver fever’ because it is most often transmitted through contaminated water from beavers to humans.
• Giardia is thought to be one of the earliest eukaryotes to evolve.

Cyanobacteria spp.

Domain: Bacteria
Size: 10 µm
Shape: Spherical (can form filaments and colonies)
Lives: Aerobic aquatic environments
Inputs/Outputs: Uses light and water for energy, produces oxygen (O₂), and makes carbon dioxide (CO₂) into glucose to build cells.

Fun Facts:
• It is thought that early cyanobacteria were responsible for producing the large amounts of oxygen (O₂) that appeared in the early Earth’s atmosphere.
Vibrio spp.

Saccharomyces cerevisiae

Clostridium spp.

Desulfovibrio desulfuricans
<table>
<thead>
<tr>
<th><strong>Vibrio spp.</strong></th>
<th><strong>Saccharomyces cerevisiae</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Domain:</strong> Bacteria</td>
<td><strong>Domain:</strong> Eukarya</td>
</tr>
<tr>
<td><strong>Size:</strong> 10 µm</td>
<td><strong>Size:</strong> 10 µm</td>
</tr>
<tr>
<td><strong>Shape:</strong> Rod or comma-shaped</td>
<td><strong>Shape:</strong> Spherical</td>
</tr>
<tr>
<td><strong>Lives:</strong> surface of plants, gastrointestinal tracts of insects and mammals, soil, fresh water</td>
<td><strong>Lives:</strong> Aerobic and anaerobic environments such as surface of plants, gastrointestinal tracts of insects and mammals, soil, fresh water, bread and beer.</td>
</tr>
<tr>
<td><strong>Inputs/Outputs:</strong> Eats sugars, breathes oxygen (O₂) and outputs carbon dioxide (CO₂) and water. Builds cells out of input sugars.</td>
<td><strong>Inputs/Outputs:</strong> Uses sugars to build cells. Produces alcohol and carbon dioxide (CO₂) through fermentation converts sugar into alcohol.</td>
</tr>
<tr>
<td><strong>Fun Facts:</strong></td>
<td><strong>Fun Facts:</strong></td>
</tr>
<tr>
<td>• Some strains of <em>Vibrio cholera</em>, one species of Vibrio, can cause the deadly disease cholera when they are infected by a particular virus. John Snow is considered the father of epidemiology (the study of the spread of disease) for his work on the cholera outbreaks from contaminated water in England in the 1850s.</td>
<td>• This yeast is often used in winemaking, brewing, and baking.</td>
</tr>
<tr>
<td>• Another species, <em>Vibrio fischeri</em>, is a bioluminescent bacterium that forms symbiotic relationships with marine animals, most notably the bobtail squid.</td>
<td>• It is also commonly used as a model organism by scientists and has been used to study aging, the cell cycle, and gene function and interactions.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Desulfovibrio desulfuricans</strong></th>
<th><strong>Clostridium spp.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Domain:</strong> Bacteria</td>
<td><strong>Domain:</strong> Bacteria</td>
</tr>
<tr>
<td><strong>Size:</strong> 1 µm</td>
<td><strong>Size:</strong> 2 µm</td>
</tr>
<tr>
<td><strong>Shape:</strong> Rod</td>
<td><strong>Shape:</strong> Rod</td>
</tr>
<tr>
<td><strong>Lives:</strong> Anaerobic environments of soil, sediment and sand.</td>
<td><strong>Lives:</strong> Anaerobic environments like guts and soil</td>
</tr>
<tr>
<td><strong>Inputs/Outputs:</strong> Eats hydrogen (H₂), alcohols and sugars, breathes sulfur or sulfate, produces sulfuric acid. Builds cells by making carbon dioxide (CO₂) into sugars.</td>
<td><strong>Inputs/Outputs:</strong> Eats sugars, produces alcohol, carbon dioxide (CO₂) and hydrogen (H₂) through fermentation. Some strains also produce acetone and butanol. Builds cells out of input sugars.</td>
</tr>
<tr>
<td><strong>Fun Facts:</strong></td>
<td><strong>Fun Facts:</strong></td>
</tr>
<tr>
<td>• Desulfovibrio causes health and safety concerns because of its metal corroding ability.</td>
<td>• Clostridium is a natural part of the human microbiota, but can cause life threatening diarrhea if it grows beyond its usually relatively low numbers.</td>
</tr>
<tr>
<td>• Desulfovibrio also shows potential for bioremediation, because it may neutralize pollutants in the soil.</td>
<td>• Another species <em>Clostridium botulinum</em> produces a neurotoxin used in Botox.</td>
</tr>
<tr>
<td></td>
<td>• Clostridium species are being used to make biofuels called biodiesel.</td>
</tr>
</tbody>
</table>
**Haloferax volcanii**

Domain: Archaea  
Size: 2 µm  
Shape: Curved discs  
Lives: Aerobic salt water  
Inputs/Outputs: Eats sugar, breathes oxygen ($O_2$), produces carbon dioxide ($CO_2$). Eats sugars to build cells.  
Fun Facts:  
- *Haloferax volcanii* can tolerate extremely salty environments such as the Great Salt Lake and the Dead Sea.

**Haloquadratum walsbyi**

Domain: Archaea  
Size: 5-10 µm  
Shape: Flat square boxes  
Lives: Aerobic salt water  
Inputs/Outputs: Eats sugar and oxygen ($O_2$), produces carbon dioxide ($CO_2$). Eats sugars to build cells.  
Fun Facts:  
- This microbe was discovered in 1980 by A.E. Walsby in a very salty brine pool in Egypt.  
- They are known for their unique square shaped cells.

**Paramecium spp.**

Domain: Eukarya  
Size: 150 µm  
Shape: Oblong oval  
Lives: Aerobic, warm stagnant water  
Inputs/Outputs: They mostly prey on bacteria, but also eat yeasts, algae, and other small protozoa for sugars. Breathes oxygen ($O_2$). Eats sugars to build cells.  
Fun Facts:  
- Some species of Paramecium like *P. caudatum* form relationships with bacteria; they host bacteria *Holospora obtusa* in the macronucleus.  
- Paramecium contain 800 copies of each gene in their genomes.

**Borrelia spp.**

Domain: Bacteria  
Size: 0.2–0.3 µm wide and 15 µm long  
Shape: Spiral-shaped  
Lives: Anaerobic environments including human and insect guts  
Inputs/Outputs: Eats sugars to build cells. Produces carbon dioxide ($CO_2$) and alcohol by fermentation.  
Fun Facts:  
- This microbe causes Lyme disease when transmitted to humans through the bite of an infected tick.
### Archaeoglobus fulgidus
- **Domain:** Archaea
- **Size:** 1 µm
- **Shape:** Spherical
- **Lives:** Anaerobic hot springs, oil wells, and hydrothermal vents in the ocean.
- **Inputs/Outputs:** Eats hydrogen (H₂), breathes sulfate (SO₄), produces sulfuric acids. Turns carbon dioxide (CO₂) to sugars to build cells.
- **Fun Facts:**
  - These microbes live in very hot temperatures and grow optimally at 83 °C (181 °F)!

### Treponema pallidum
- **Domain:** Bacteria
- **Size:** 15 µm long
- **Shape:** Spiral-shaped
- **Lives:** Anaerobic environments inside of mammals (i.e. mucus membranes)
- **Inputs/Outputs:** Eats sugars and amino acids, produces alcohols and carbon dioxide (CO₂). Eats sugars to build cells.
- **Fun Facts:**
  - This bacterium cannot be cultured and investigated using common lab techniques. Genome sequencing is, therefore, extra important in allowing scientists to better understand how this microbe causes the disease syphilis.

### Methanobrevibacter smithii
- **Domain:** Archaea
- **Size:** 1 µm
- **Shape:** Shape between a sphere and a rod
- **Lives:** Anaerobic environments including the human gut
- **Inputs/Outputs:** Eats hydrogen (H₂), alcohol, and carbon dioxide (CO₂); produces methane (CH₄). Turns carbon dioxide (CO₂) to sugars to build cells.
- **Fun Facts:**
  - Plays an important role in the digestion of complex sugars where it may contribute to obesity in humans.

### Geobacter metallireducens
- **Domain:** Bacteria
- **Size:** 1 µm
- **Shape:** Rod-shaped
- **Lives:** Anaerobic soil
- **Inputs/Outputs:** Eats sugars, breathes iron, produces rust. Turns carbon dioxide (CO₂) to sugars to build cells.
- **Fun Facts:**
  - Geobacter plays a role in bioremediation, helping turn contaminants into less harmful forms.
  - Geobacter can produce electricity and has been used to power microbial fuel cells. This microbe produces tiny conductive nanowires to connect to iron and other metals.
  - Geobacter can survive for two hours at 130 °C (266 °F).
Methanosarcinae spp.

Sulfolobus islandicus

Methylcoccus spp.

Rhodopseudomonas spp.
**Sulfolobus islandicus**

**Domain:** Archaea  
**Size:** 1 µm  
**Shape:** Irregular  
**Lives:** Aerobic, acidic hot springs (like those found in Yellowstone National Park)  
**Inputs/Outputs:** Eats hydrogen sulfide (H\(_2\)S) or sugars, breathes oxygen (O\(_2\)), produces carbon dioxide (CO\(_2\)) and sulfuric acid.  
**Fun Facts:**  
- Their ideal environment is very acidic (pH 2–3) and high temperatures of 75–80 °C (167–176 °F).  
- Sulfolobus cells can be infected by many different viruses. They combat infection using a microbial form of adaptive immunity.

**Methanosarcinae spp.**

**Domain:** Archaea  
**Size:** 1 µm  
**Shape:** Irregular spheres  
**Lives:** Anaerobic environments including oil wells, sediment, soil, wastewater treatment plants, and cow rumen.  
**Inputs/Outputs:** Eats hydrogen (H\(_2\)) and alcohols, breathes carbon dioxide (CO\(_2\)) produces methane (CH\(_4\)). Turns carbon dioxide (CO\(_2\)) to sugars to build cells.  
**Fun Facts:**  
- Based on what is available in their environment, they can alternate between three different metabolic pathways to produce methane.  
- Methanosarcinae produce methane or natural gas which can be used as a biofuel.  
- Methanosarcinae and other methanogens were the organisms Carl Woese first used to identify the Archaea.

**Rhodopseudomonas spp.**

**Domain:** Bacteria  
**Size:** 1 µm  
**Shape:** Rod-shaped  
**Lives:** Anaerobic or aerobic marine environments.  
**Inputs/Outputs:** Uses light and hydrogen sulfide (H\(_2\)S) for energy. Produces sulfate. Turns carbon dioxide (CO\(_2\)) to sugars to build cells. Can also eat sugars and breathe oxygen (O\(_2\)) to produce (CO\(_2\)).  
**Fun Facts:**  
- Rhodopseudomonas can be identified by its purple color and is known for its ability to switch between four different metabolic processes based on what is available in its environment.

**Methyllococcus spp.**

**Domain:** Bacteria  
**Size:** 1 µm  
**Shape:** Spherical  
**Lives:** Aerobic soil environments  
**Inputs/Outputs:** Eats methane (CH\(_4\)) and breathes oxygen (O\(_2\)). Produces carbon dioxide (CO\(_2\)) and uses it to make sugars and build cells.  
**Fun Facts:**  
- By consuming methane, a potent greenhouse gas, Methyllococcus in the soil can mediate climate change. As tundra warms and methane emissions increase, organisms like this microbe are a focus of climate science.